IES Newsletter

Volume 6, Number 2
March - April 1989

At the Arboretum

"What is an ecosystem?" The Institute's Public Education Program, with support from the New York State Council on the Arts, has built a walk-through pond ecosystem to help answer this question. The pond is a part of the IES Outdoor Science Center behind the Gifford House, and Laury Zicari, program specialist in exhibit design, expects the model ecosystem to be completed by mid-summer.

Sunday Ecology Programs will continue throughout the summer. See the schedule in the calendar on page 4.

Arboretum visitors should not be put off by the "Route 44A Detour" signs. West of the Village of Millbrook turn off Route 44 onto Route 44A (east of the Dutchess County Farm and Home Center). The bridge construction is east of the Arboretum.

The IES Newsletter is published by the Institute of Ecosystem Studies at the Mary Flagler Cary Arboretum. Located in Millbrook, New York, the Institute is a division of The New York Botanical Garden. All newsletter correspondence should be addressed to the Editor.

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Selectivity and Success in Plants

Have you ever opened a pea pod and noticed that some of its contents may be just mere suggestions of peas? Have you ever wondered why an apple tree may produce only a few dozen fruit, when four months earlier that same tree was covered with apple blossoms? What happened in each case was the natural process of seed and fruit abortion, a process that captured the imagination of plant ecologist Dr. Thomas D. Lee early in his research career.

Dr. Lee observed trees such as the catalpa, which has gigantic floral displays but few fruits; the pawpaw, with many flowers but only a few large fruits; and the horse chestnut, which, if it filled all its flowers, would fall over from the weight of its fruit. His observations prompted him to ask the question "What factors limit seed production in natural plant communities?", and he chose to work with the partridge pea (*Cassia fasciculata*), a yellow-flowered annual legume that grows in fields throughout eastern North America. He selected the partridge pea for three reasons. First, because the plant's entire life cycle is completed in a year, seed production is vital to its survival. Also, partridge pea is easily grown and studied in greenhouses. Finally, it is convenient to work with.

The biology of a flower

A typical flower has four parts. Two of these, the sepals and the petals, are the showy part but are not of direct relevance here. The other two parts, however, are worth a quick note. The stamen is the male part of the flower, and usually consists of a stalk with the pollen-bearing anther. The pistil is the female part, with three sections: the stigma, at the tip; the style, or neck; and the ovule-containing ovary at the base. Fertilization of the flower occurs through pollination. When pollen is released from the anther, it is carried by wind or insects to the stigma. Pollen tubes extend through the style to the ovary, where, following fertilization, ovules develop into seeds. The ovary itself matures into a fruit.

Limiting seed production

There are three factors that can potentially limit the production of seeds in a plant: 1) limited physical resources (water, nutrients, light); 2) limited pollen (not enough pollinators or pollinators of the wrong type); or 3) predators and/or pathogens. To what extent does each limit the number of seeds that partridge pea produces? Dr. Lee found that under natural conditions the most significant limiting factor was inadequate physical resources. Only a portion of the plant's fruits could develop to the point of seed maturation when water, nutrients and/or light were reduced. Studies by other scientists have shown the same thing: "June drop" in apple trees, for example, occurs when apples are aborted because of limited resources. This is a means of self-regulation in plants, where more fruits and seeds are initiated than can possibly be filled. Prevailing environmental conditions then cause the dropping of as many as

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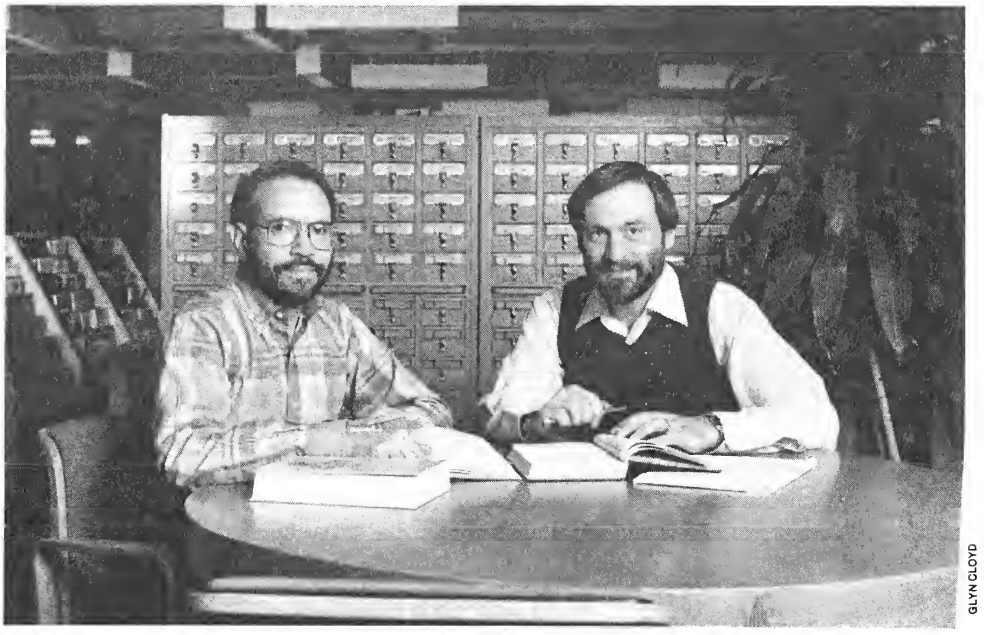


GLYN GLOYD

IES plant ecologist Dr. Steward T. A. Pickett, left, and Dr. Thomas D. Lee. During Dr. Lee's six-month stay at the Institute he has worked closely with Dr. Pickett and others on questions of community ecology.

Success, *from page 1*

necessary to ensure continued health of the remaining fruit and the parent plant.

Another advantage to producing more flowers than can be converted to fruits — as in the abundance of apple blossoms and the catalpa's gigantic floral displays mentioned earlier — has to do with pollination. Dr. Lee and others suggest that this overproduction of flowers may be a means of attracting greater numbers and varieties of pollinators. Or it could be that the overproduction of flowers and juvenile fruits is a hedge against environmental uncertainty. Since some flowers are destined to develop into fruits that will abort, is there a way to predict which flowers and fruits will succeed and which will not?

Predicting success of flowers and fruits

Using the partridge pea, Dr. Lee looked at three factors that might determine which flowers actually produce fruits. The first is the time of initiation of the young flower. Flowers that are initiated early tend to have a greater chance of survival because resources are used up during fruit development. By the time later flowers appear there are fewer nutrients available to support them.

The source of the pollen that reaches the female flower may also be important. It is known that in some species of plants there is a strong "paternity effect" ... some pollen donors are simply more successful fathers — either in general or with specific mothers — than others. This is true for the trumpet creeper, the showy milkweed and the wild radish, but not, Dr. Lee found, for the partridge pea.

The third factor that can affect the number of successful flowers and fruits is pollination intensity, or the number of pollen grains that are deposited on the stigma. Under laboratory conditions it was possible to vary pollination intensity by "diluting" the pollen with an inert substance, such as talcum powder. Dr. Lee found that reducing pollen quantity on the *Cassia* stigma led to reduced seed production.

Selectivity

He also saw a strong correlation between the number of seeds and the success of the fruit: partridge pea fruits with fewer seeds were aborted. Why does partridge pea abort fruits from light pollination? When Dr. Lee investigated reasons for this selectivity, he found that "cost" to the plant was a determining factor. It takes a considerable amount of energy for the plant to make the wall of the fruit, or the pod. The plant will make the pod independent of the number of seeds it will contain, but it costs about three times as much, per seed, to make a 2-seeded as a 12-seeded fruit. Since lighter pollen loads result in pods with fewer seeds, Dr. Lee thinks that this may be the primary reason that *Cassia* aborts those fruits with lighter pollen loads.

Depending on the plant, pollination intensity may affect selectivity in other ways. Research has demonstrated that in the case of zucchini, for example, competition among pollen grains may be most significant. When pollen loads are heavy, it is possible to select for the pollen with the fastest-growing pollen tubes: only the most vigorous will reach the ovules. In cases of a light pollen load, there is no competition, and any grain may succeed in fertilizing the ovule. Rapid pollen tube growth is often correlated with rapid seedling growth, so selectively filling fruits from heavy pollination may mean a crop of more vigorous seeds.

In summary ...

There is tremendous variety in the appearance of plants. Research on the reproductive ecology of plants is showing that there is also considerable variety in the way that these plants can increase the vigor of future generations. Dr. Lee's studies with the partridge pea showed that fruits resulting from heavy pollination and containing high seed numbers are rarely aborted. In other species of plants, seed and fruit success may be related to a host of factors including availability of resources and pollen source.

* * * * * * * * * * *

Dr. Thomas D. Lee is an associate professor of botany at the University of New Hampshire in Durham. As a plant ecologist, he teaches courses in terrestrial plant ecology, physiological plant ecology and community ecology. While doing his studies of reproductive ecology, he found himself developing an increasing interest in plant community ecology: he wanted to learn more about what controls abundance and diversity of species in plant communities, and he felt that community ecology had much to offer in terms of helping to solve environmental problems.

In January, he took a six-month leave from the University of New Hampshire to pursue this new research interest. He chose to study at the Institute of Ecosystem Studies because of its leadership in plant community ecology. While at IES, he is working with staff scientists and the resources in the Institute's library to develop ideas for new areas of research. He is also sitting in on discussions with the scientists of the Institute's rights-of-way project (described in the May-June 1988 issue of the IES Newsletter), a project that he sees as a model for how basic plant community ecology can contribute to sound land management.

Perennial Garden Highlights

Mid-May
Rhododendron species and cultivars in white, yellow and shades of pink and purple
Phlox species (Creeping Phlox), and cultivars
Waldsteinia ternata
Dicentra eximia "Luxuriant"
Mertensia virginica (Virginia Blue Bell)

Early June
Paeonia (Peony) including "Burma Ruby", "White Innocence", "June Brilliant", "E.G. Hill" & "Many More"
Papaver (Poppy) including "White King", "Raspberry Queen", "Helen Elizabeth", "Carnival" & "Bonfire"
Dianthus gratianopolitanus "Tiny Rubies" (Cheddar Pink)
Artemisia versicolor (Wormwood)

Mid- to Late June
Astilbe species and cultivars
Iris siberica "Ottawa" and "Skywing"
Veronica latifolia "Crater Lake Blue" (Speedwell)
Adiantum pedatum (Maidenhair Fern)
Nepeta x fassenii (Catnip)
Rose, Herb & Hosta beds
Asian/North American bed
Ornamental Grass Garden

Early to mid-July
Phlox paniculata "Star Fire" and "Everest"
Asclepias tuberosa (Butterfly Weed)
Ligularia stenocephala "The Rocket"
Echinops ritro "Taplow Blue" (Small Globe Thistle)
Monarda didyma "Croftway Pink" (Bee Balm)

... and many more ...

Promotions

JONATHAN J. COLE and **MICHAEL L. PACE** have been promoted to IES associate scientists. The promotions were based on appraisals from distinguished scientists outside IES and on an internal review. In a recent announcement, IES Director Dr. Gene E. Likens wrote that the appraisals of work done by the two ecologists "reflect ... the excellent progress in (the scientists') careers and the promise of continuing contributions to science."

GLYN CLOYD

Dr. Jonathan J. Cole

Dr. Cole, an aquatic microbiologist, has been with the Institute since September 1983. His current research deals with both freshwater and saltwater ecosystems, with projects in progress at sites along the Hudson River, at Mirror Lake in New Hampshire's Hubbard Brook Experimental Forest, and in the Atlantic Ocean. He is especially interested in primary production (the rate at which the sun's energy is stored as food material, primarily by the photosynthetic activity of simple floating plants) and the nutrients — nitrogen and phosphorus — that limit this process.

Dr. Pace is an aquatic ecologist who arrived at IES in January 1986. He studies the ecology of bacteria, protozoa and zooplankton, organisms that are responsible for much of the decomposition, recycling and productivity of freshwater ecosystems. In addition to doing studies of lakes in New York and Michigan, Dr. Pace is working on the Hudson River to determine the factors that control zooplankton populations — and perhaps ultimately striped bass populations.

In a project begun just recently, Drs. Cole and Pace are collaborating with IES post-doctoral associate Dr. Nina Caraco on a study of the Hudson River-New York City Bight system to see if acid rain, with its high nitrogen levels, could be a cause of eutrophication in coastal waters (eutrophication is the overenrichment of a body of water with nutrients — such as nitrogen — resulting in excessive growth of microscopic organisms and depletion of oxygen).

GLYN CLOYD

Dr. Michael L. Pace

John S. Eaton Fellowship

The Institute of Ecosystem Studies is pleased to offer the John S. Eaton Fellowship in Laboratory Sciences. This fellowship was established in 1988 following the June death of John Eaton, forest ecologist and IES laboratory manager whose meticulous research and great enthusiasm served as a model to all with whom he worked.

Candidates for Eaton Fellow are being considered now. The recipient will spend up to three months in the Institute's analytical laboratory doing research, learning analytical techniques, working with state-of-the-art scientific equipment and collaborating with Institute staff. The Eaton Fellow will have the opportunity not only to learn and/or develop methods in analytical chemistry, but also to perpetuate the unique insight and values that John Eaton brought to ecological science.

This fellowship is supported by friends and colleagues of John Eaton. For more information, contact Kathleen C. Weathers, Chair, Eaton Fellowship Committee, c/o IES. Those wishing to make donations should send them to Dr. Gene E. Likens, Director, IES.

New Staff

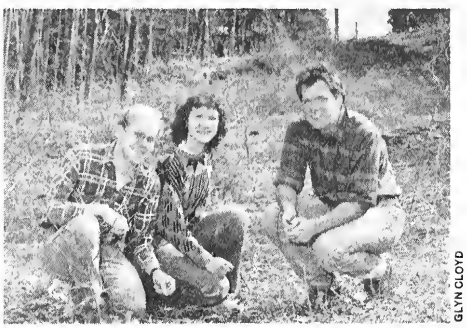
KENNETH M. MULLEN, Comptroller, is responsible for IES accounting, budget control and preparation, and purchasing. He holds a master's degree in business administration from the University of Toledo, and most recently was the administrator for business affairs at the Department of Internal Medicine, Wayne State University in Detroit.

GLYN CLOYD

Three research assistants have joined the utilities rights-of-way research project: **HAROLD D. FRALEIGH, JR.**, research assistant I, has been involved with this study as a temporary project assistant since December 1984, and is now a full-time assistant. Working with plant ecologist Dr. Charles Canham, he is determining the effects of wildlife eating habits on the establishment, growth and survival of tree seedlings in plant communities along power line rights-of-way. Mr. Fraleigh has a bachelor of science degree in plant breeding from Cornell University's College of Agriculture and Life Sciences.

JOYCE N. RUSSELL, research assistant I, graduated from Wheaton College, Norton, Massachusetts a year ago with a bachelor of arts degree in biology. Working with plant ecologist Dr. Alan Berkowitz as well as with Dr. Canham, she is doing field experiments on interactions between tree seedlings and shrub and herbaceous plant communities.

DIRK VAN DORP, research assistant II, is working with terrestrial ecologist Dr. Mark McDonnell. He is designing and doing field and laboratory experiments to learn how seed predation by small mammals and birds affects the way trees invade rights-of-way plant communities. Mr. Van Dorp has a master of science degree from the University of Nymegen in the Netherlands.



GLYN CLOYD

Research assistants on a utility right-of-way. L to R: Harold Fraleigh, Joyce Russell and Dirk Van Dorp.

Local Weather

Data collected at the IES Weather Station provide background information for ecological research at the Institute and serve as a standard against which long-term trends in weather and air quality may be compared.

January and February, 1989

Highest temperature: 18.1° C (64.6° F) on February 1st
Lowest temperature: - 17.9° C (- 0.2° F) on January 5th
Daily average temperature: - 2.0° C (28.4° F)
(Normal*: -4.3°C (24.3°F)
Precipitation: 9.16 cm (3.6 in.)
(Normal: 13.18 cm (5.18 in.)
Average rainfall pH**: 4.08

* "Normal" values are taken from data collected for a 30-year period at the Millbrook School

** Degrees of acidity or alkalinity are indicated using a logarithmic pH scale. On the scale of 0-14, vinegar — an acid — has a pH of approximately 3, and "neutral" is 7.0. The pH of "normal" rain is 5.6 or higher.

Needed: Temporary Housing

Each year, especially from mid-May through August, the Institute hires college students to assist with research and public education projects. Because our growing programs attract increasing numbers of students, occasional housing shortages in IES dormitories are inevitable. If any local readers would like to rent rooms or apartments to our students on a short-term basis, or to arrange for house-sitters, please contact Julie Morgan, housing coordinator, at 677-5343 during business hours.

Spring/Summer Calendar

SUNDAY ECOLOGY PROGRAMS
Free public programs are offered on the first and third Sunday of each month, except over holiday weekends. All programs are from one to two hours long, and begin at 2:00 p.m. at the Gifford House on Route 44A unless otherwise noted.

Tentative schedule (please call (914) 677-5359 to confirm the day's topic):

June 18th Exploration of the Acid Rain Study Ponds (Merrily Gere) — Demonstration

July 16th How Plants Defend Themselves (Dr. Clive Jones) — Walk

Aug. 6th Ecology of a Spring-fed Stream (Dr. David Strayer) — Walk

Aug. 20th Ozone Pollution, Ozone Depletion and the Greenhouse Effect: Sorting It All Out (Dr. Gary Lovett) — Walk

For ecology walks, dress according to the weather with long pants, socks and sturdy, waterproof footwear. In case of inclement weather, call (914) 677-5358 after 1 p.m. to learn the status of the day's program.

OUTDOOR SCIENCE CENTER
Located behind the Gifford House Visitor and Education Center, the growing Outdoor Science Center features a new display answering the question: "**What is an ecosystem?**" This three-dimensional walk-through model shows the living and non-living components of a pond ecosystem — wetland plants, frogs, fish, water, soil and bedrock — from below the surface of the "water". This display is nearing completion. Other displays in the Outdoor Science Center are the **Acid Rain Study Ponds** and the **Air Pollution Garden.**

The Outdoor Science Center is open throughout the summer during Arboretum hours. Admission is free with a visitor permit.

ART EXHIBIT
"A Garland of the Seasons", a collection of nature photographs by Margaret Moebius Reifeiss, is at the Plant Science Building through August 4th.
Hours: 9 a.m. - 4 p.m. weekdays. Free.

GREENHOUSE
The IES Greenhouse is a year-round tropical plant paradise as well as a site for controlled environmental research. The public is invited to explore both aspects during Arboretum hours. There is no admission fee, but visitors should first stop at the Gifford House for a free permit.

GIFT SHOP
Father's Day and Pre-Inventory Sale: June 3-17.
Senior Citizens Days: During June, July and August, senior citizens receive a 10% discount on all purchases (except sale items). Garden "mini-tour" on the last Wednesday of each month ... call 677-5358 weekdays for information.

ARBORETUM HOURS
(Summer Hours: May 1 - September 30)
The **Arboretum** is open Monday through Saturday, 9 a.m. to 6 p.m.; Sunday 1 - 6 p.m.
(The **Greenhouse** and **Plant Science Building** continue to be closed to visitors at 4 p.m. during summer hours.)
The **Gift and Plant Shop** is open Tuesday through Saturday 11 a.m. to 5 p.m. and Sunday 1 - 5 p.m. (closed weekdays from 1 - 1:30 p.m.).

All visitors must obtain a free permit at the Gifford House for access to the Arboretum. Permits are available up to one hour before closing time. (The Arboretum is closed on public holidays.)

MEMBERSHIP
Become a member of the Mary Flagler Cary Arboretum. Benefits include a special member's rate for IES courses and excursions, a 10% discount on purchases from the Gift Shop, free subscriptions to the IES Newsletter and *Garden* (the beautifully illustrated magazine for the enterprising and inquisitive gardener), and parking privileges and free admission to the Enid A. Haupt Conservatory at The New York Botanical Garden in the Bronx. Individual membership is $25; family membership is $35. For information on memberships, contact Janice Claiborne at (914) 677-5343.

For more information, call (914) 677-5359 weekdays from 8:30 - 4:30

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Permit No. 16